PHOTODEGRADATION OF NAPHTHALENE BY USING BINARY TiO_2/CuO AND WO_3/CuO CATALYSTS

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Dedicated to my beloved family…

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ABSTRACT

Naphthalene is one of polycyclic aromatic hydrocarbons (PAHs) compounds which have been identified as carcinogenic. It is commonly used in industry and domestic. Therefore, it can cause environmental pollution and must be treated. One of the promising methods to remove this pollutant from waste water is by using photocatalyst since it can degrade the pollutant without producing toxic by-products. In this research, two types of photocatalysts namely TiO_2/CuO and WO_3/CuO were prepared with different mass ratio of co-catalyst and it was calcined at various temperatures. TiO_2 was prepared by sol-gel method while WO_3 by aging amorphous peroxo-tungstic acid. The characterizations of the prepared catalysts were done by XRD, FESEM and BET surface area analyzer. XRD patterns revealed that TiO_2/CuO calcined at 450 °C and 650 °C consists of single phase anatase and rutile respectively while TiO_2/CuO calcined at 550 °C consist of a mixture of anatase and rutile. XRD patterns for WO_3/CuO catalyst indicated that the catalyst consist of single phase of WO_3. FESEM micrographs showed TiO_2/CuO particles were packed loosely compared to WO_3/CuO particles which were small and packed closely. BET analysis discovered that WO_3/CuO catalyst has larger surface area than TiO_2/CuO catalyst. The influence of pH, photocatalyst loading and the uses of different light radiation sources were studied. The reaction was monitored by UV-Vis spectrophotometer. Photocatalytic reaction performed best in neutral medium irradiated with UV light. The optimum mass percent of co-catalyst for both photocatalysts were 10% and the calcination temperature for WO_3/CuO and TiO_2/CuO photocatalysts was 650 °C and 550 °C respectively. The result indicated that the percentage of photodegradation for WO_3/CuO and TiO_2/CuO in neutral environment was 88.60% and 63.55% respectively. TiO_2/CuO removed 11.01% and 33.60% of pollutant in basic and acidic environment respectively. WO_3/CuO degraded 48.03% of pollutant in acidic environment while in basic environment it degraded 46.32% of pollutant. The optimum photocatalyst loading was 0.2 g for both photocatalysts. 0.2 g of WO_3/CuO (90:10 650 °C) degraded 93.23% of pollutant while 0.2 g of TiO_2/CuO (90:10 450 °C) removed 60.9 % of it.

ABSTRAK

Naftalena adalah salah satu sebatian hidrokarbon polisiklik aromatic (HPA) yang telah dikenal pasti sebagai karsinogen. Ia biasanya digunakan dalam industri dan domestik. Oleh itu ia boleh menyebabkan pencemaran alam sekitar dan mestilah dirawat. Salah satu kaedah yang berkesan untuk menghapuskankan bahan cemar ini daripada air kumbahan adalah dengan menggunakan fotomangkin kerana ia boleh menghilangkan bahan cemar tanpa menghasilkan produk sampingan yang bertoksid. Dalam kajian ini, dua jenis fotomangkin iaitu TiO_2/CuO dan WO_3/CuO telah disediakan dengan nisbah peratusan jisim pemangkin bersama yang berbeza dan dikalsin pada pelbagai suhu. TiO_2 telah disediakan dengan kaedah sol-gel manakala WO_3 dengan mematangkan asid amorfus peroxo-tungstic. Pencirian fotomangkin yang disediakan telah dilakukan dengan XRD, FESEM dan analysis luas permukaan BET. Pola XRD mendedahkan bahawa TiO_2/CuO yang dikalsin pada suhu 450 °C dan 650 °C masing-masing terdiri daripada fasa anatase dan rutile manakala TiO_2/CuO dikalsin pada suhu 550 °C terdiri daripada campuran anatase dan rutile. Pola XRD bagi WO_3/CuO pemangkin menunjukkan bahawa pemangkin terdiri daripada fasa tunggal WO_3. Mikrograf FESEM menunjukkan zarah TiO_2/CuO adalah kurang padat berbanding dengan zarah WO_3/CuO yang yang kecil dan padat. Analisis BET mendapati bahawa pemangkin WO_3/CuO mempunyai luas permukaan yang lebih besar daripada pemangkin TiO_2/CuO. Pengaruh pH, jisim fotomangkin dan penggunaan sinaran lampu yang berbeza telah dikaji. Tindak balas telah dipantau oleh UV-Vis spektrofotometer. Prestasi fotomangkin terbaik adalah dalam medium neutral dan disinari dengan cahaya UV. Jisim peratus pemangkin bersama yang optimum bagi kedua-dua fotomangkin adalah 10% dan suhu pengkalsinan untuk fotomangkin WO_3/CuO dan TiO_2/CuO masing-masing adalah 650 °C dan 550 °C. Keputusan eksperimen menunjukkan bahawa fotomangkin WO_3/CuO dan TiO_2/CuO masing-masing menyingkirkan 88.60% dan 63.55% bahan cemar dalam persekitaran neutral. TiO_2/CuO menyingkirkan 11.01% dan 33.60% bahan pencemar dalam persekitaran beralkali dan berasid. WO_3/CuO menyingkirkan 48.03% bahan pencemar dalam persekitaran berasid manakala dalam persekitaran beralkali ia menyingkirkan 46.32% bahan cemar. Muatan fotomangkin yang optimum adalah 0.2 g bagi kedua-dua fotomangkin. 0.2 g fotomangkin WO_3/CuO (90:10 650 °C) menyingkirkan 93.23% bahan cemar manakala 0.2 g fotomangkin TiO_2/CuO (90:10 450 °C) menghilangkan 60.93% bahan cemar.